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# iMAIN

## Predictive Maintenance in Forming Machines

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advanticsys 

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**iMAIN**  
PROJECT

Maintenance in  
Factories of the Future

  
SEVENTH FRAMEWORK  
PROGRAMME

  
IWP  
WERKZEUGMASCHINEN  
UND PRODUKTIONSPROZESSE

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# Agenda

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## iMAIN

Novel Maintenance Support System  
for Forming Presses

### 1. Motivation

### 2. Challenges

### 3. Approach

### 4. Solutions

# 1. Motivation

## Motivation for predictive maintenance

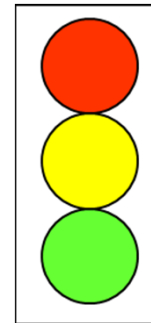
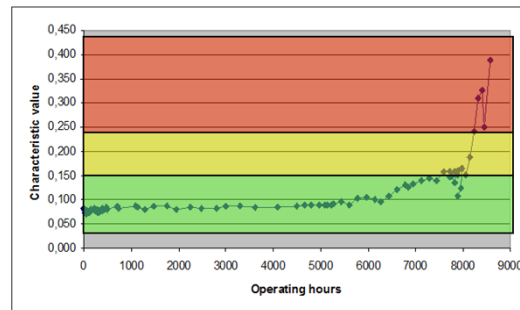
Acting **reactive**



Acting **proactive**

### Provide opportunities to carry out a preventive condition dependent maintenance

- Cost reduction (reduction of spare part reserve, maintenance operations can be planned),
- Increase in productivity (reduction of downtime), reliability and availability



 **But: a large amount of information and expert knowledge is needed!**

## 2. Challenges

### Special challenges in forming machines & other high-loaded systems

- Preventive maintenance strategy for fatigue problems
- Complex strain and stress monitoring
- Main problem: direct strain measurement often not possible
  - functional and inner geometries not accessible
  - high number of potential fracture critical locations
  - variable load conditions

#### SERVO PRESS IWU

test bench with servo drives



#### RAVNE SE2-800T

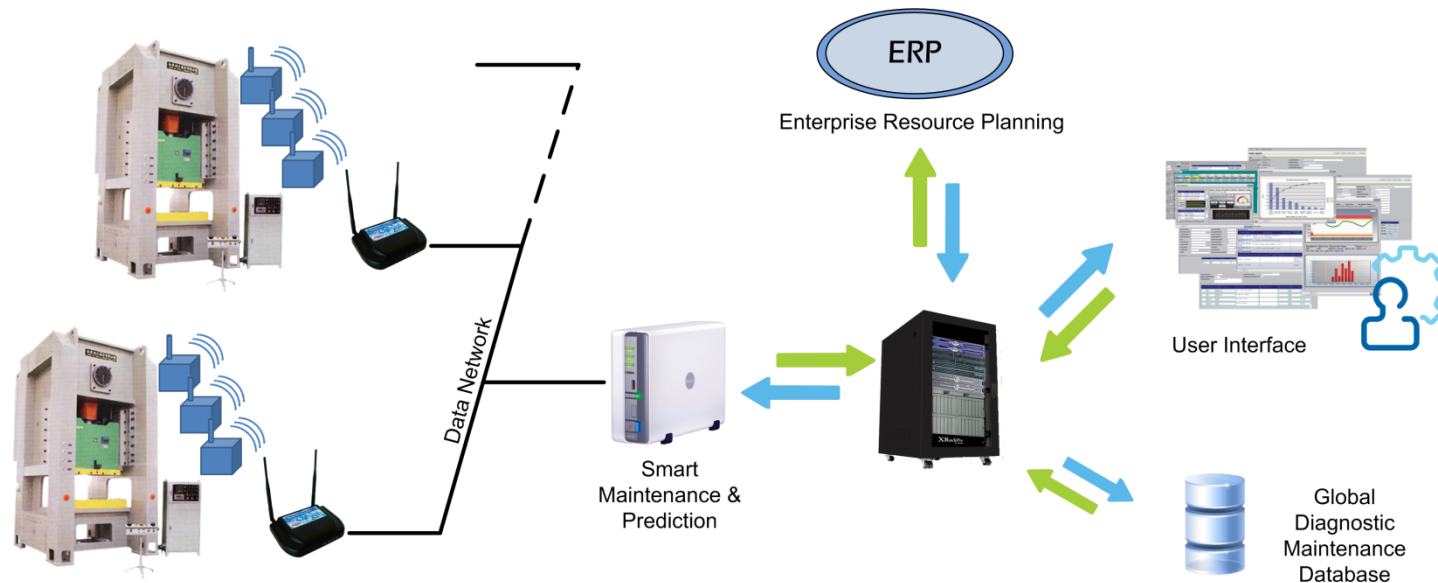
with conventional drives (flywheel and belt)



# 3. Approach

## Maintenance approach

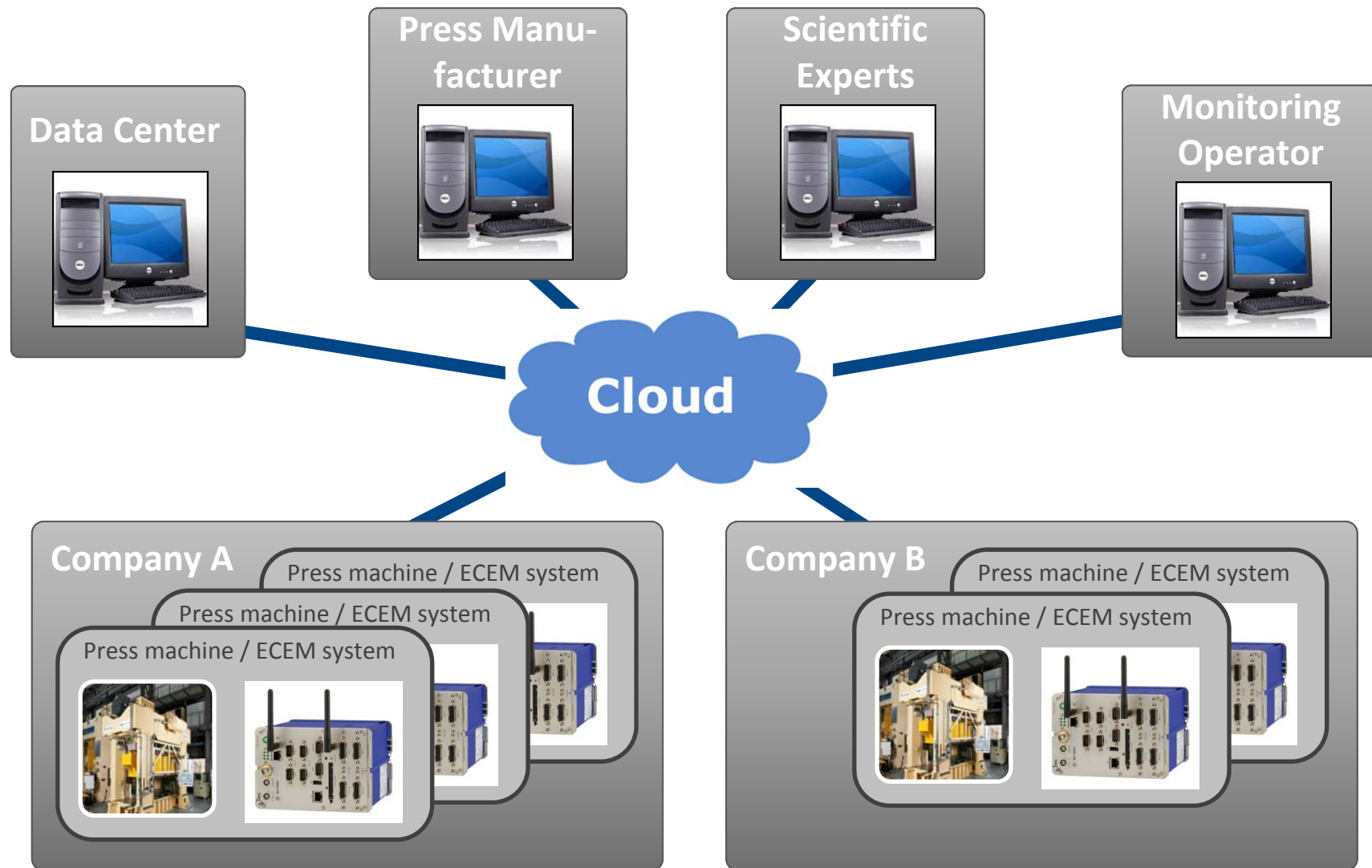
- Novel concept of an eMaintenance support system for service life prediction of mechanical components of high-loaded systems like forming presses
- based on a network of intelligent information and processing agents
- Embedded stress monitoring system, stress and load history data base
- Service life prediction by cumulative fatigue hypothesis
- Control-inherent -, wireless – and model-based virtual sensors
- ERP and PP interface



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## 4. Solutions

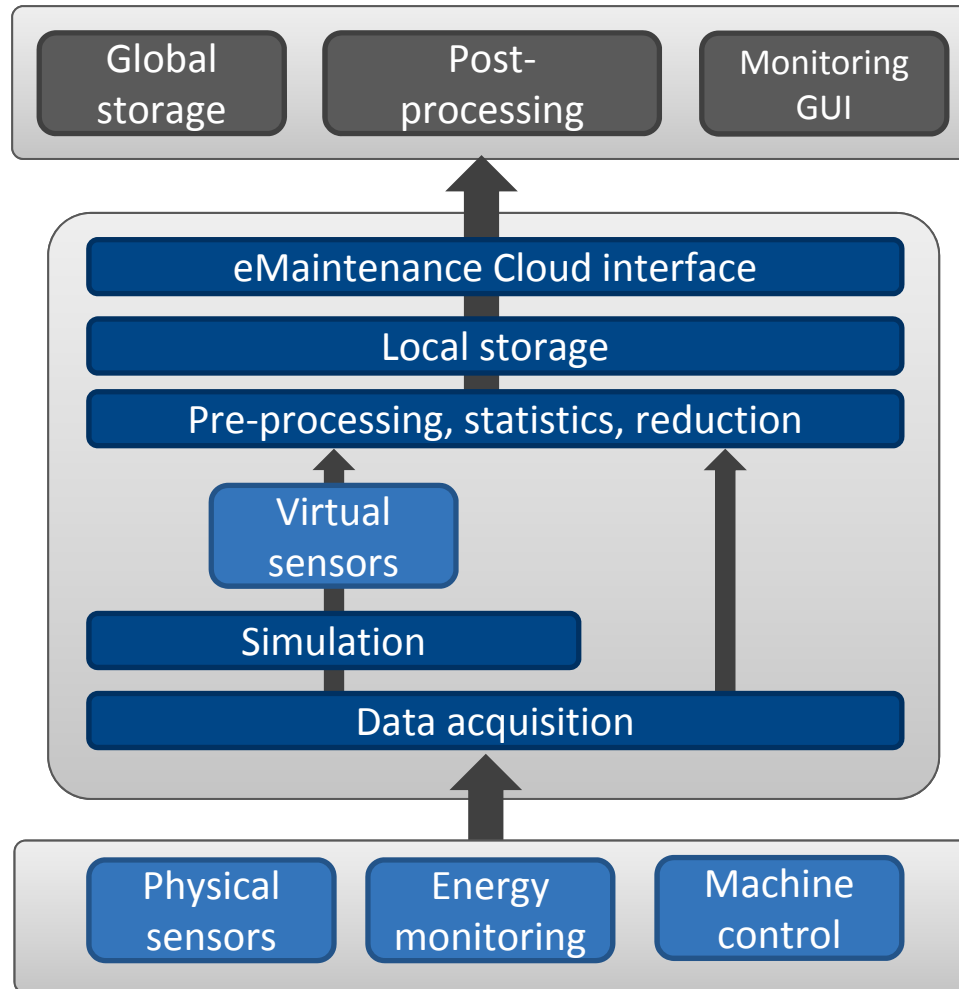
### Distributed Condition Monitoring Environment



## 4. Solutions

### ECEM – The Embedded Condition and Energy Monitoring

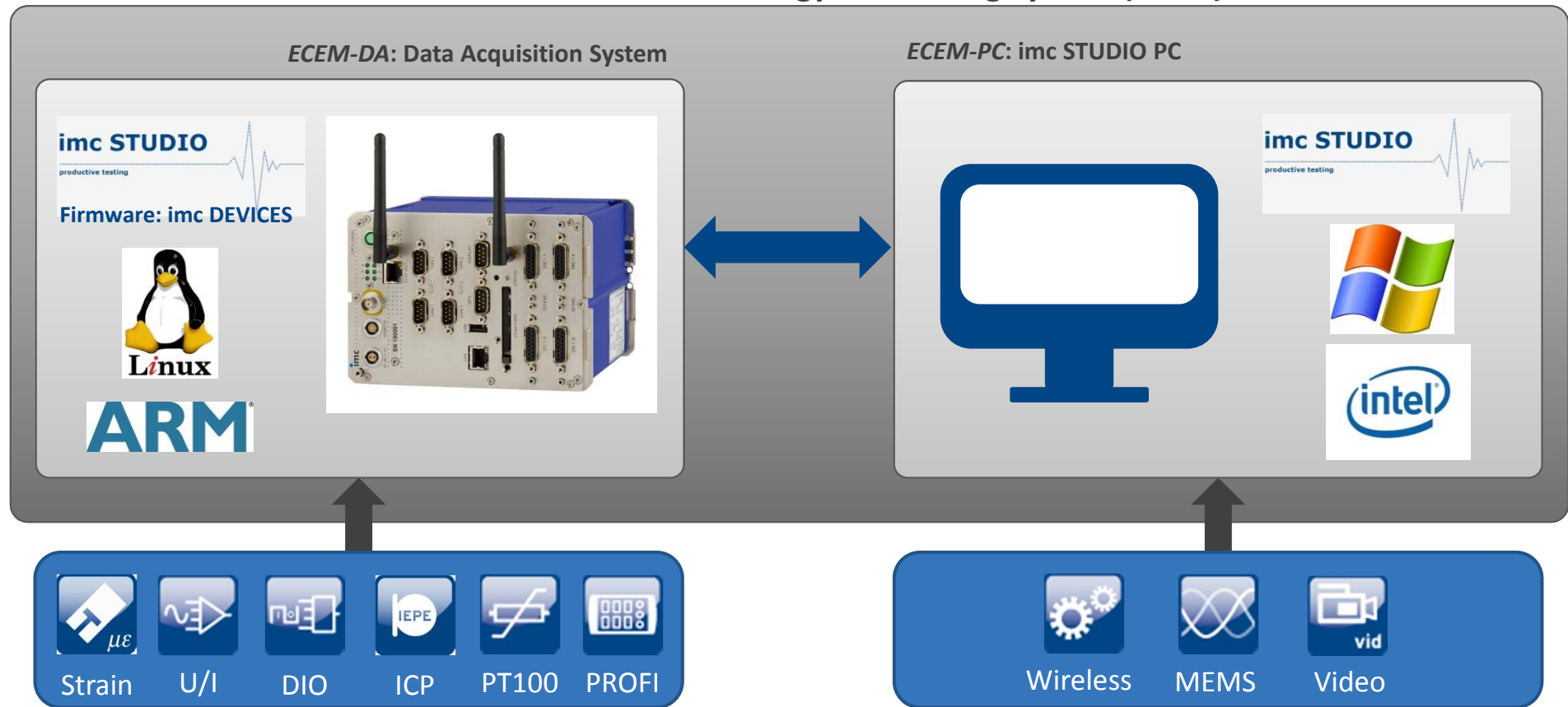
System context



## 4. Solutions

### ECEM – The Embedded Condition and Energy Monitoring System context

#### Embedded Condition and Energy Monitoring System (ECEM)



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# 4. Solutions

## ECCEM – Sub Tasks: Data acquisition

### Strain gauge

- stress on frame structure, simulation



### Noise , vibration

- bearing analysis
- MEMS and ICP sensors



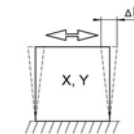
### Machine infrastructure (lubrication, pneumatic)

- indirect wear indicators: oil quality, air loss, temperature
- 4..20 mA, PT100 and CAN-based sensors



### Slide displacement, belt vibration

- direct sensing of ram tilting
- 4..20 mA displacement sensors



### Power meter, machine control

- PROFIBUS

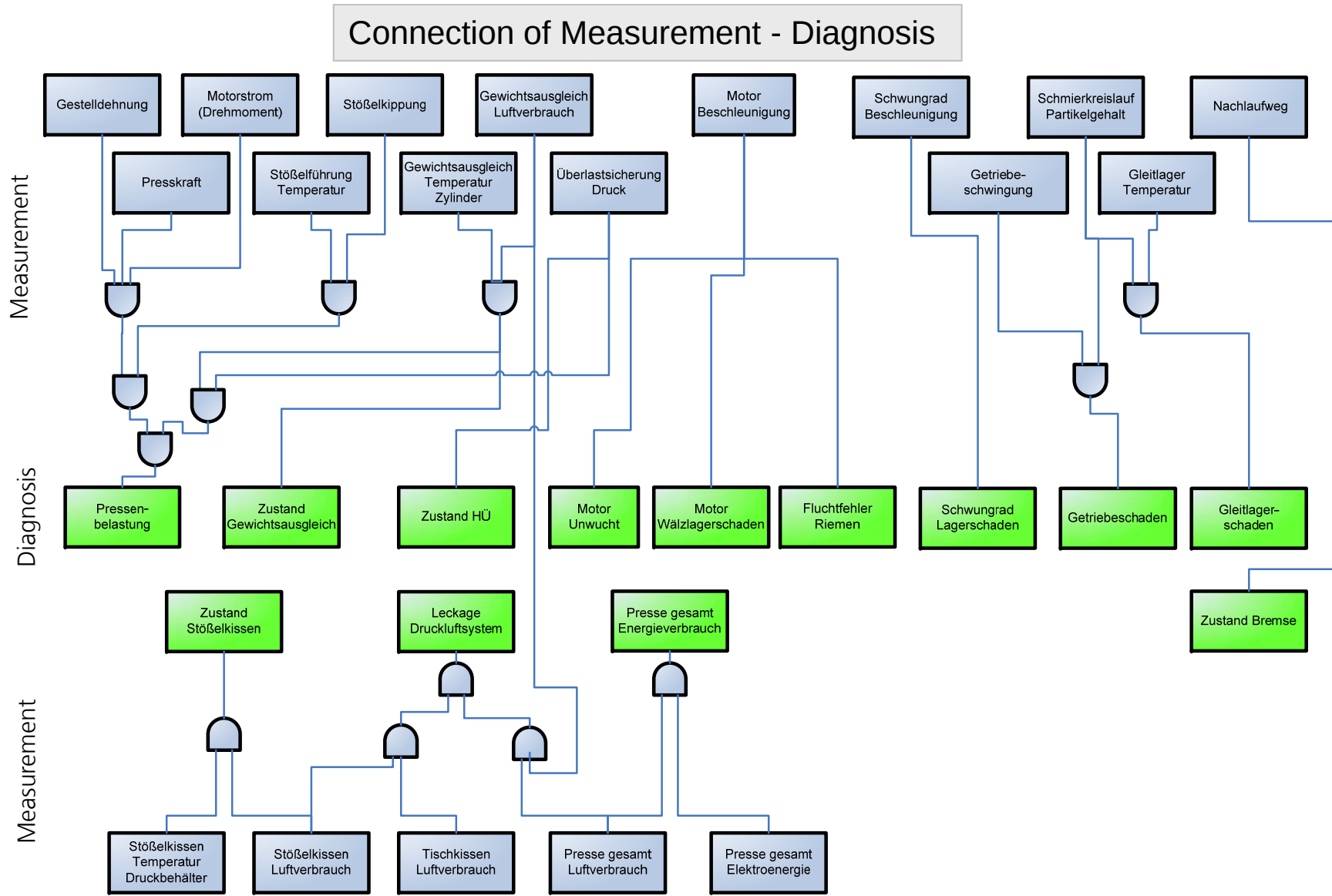


### Wireless temperature sensors

- indirect measure for friction / ram tilting
- Ethernet based wireless concentrator ...



## 4. Solutions



## 4. Solutions

### ECEM – Sub Tasks: Strain (stress) measurement

#### what?

- mechanical load and stress

#### why?

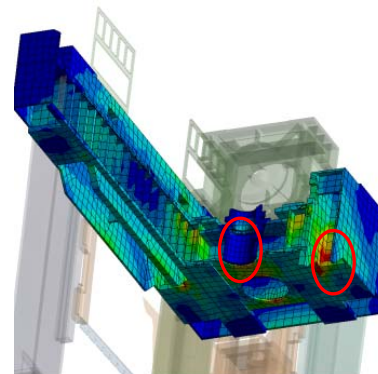
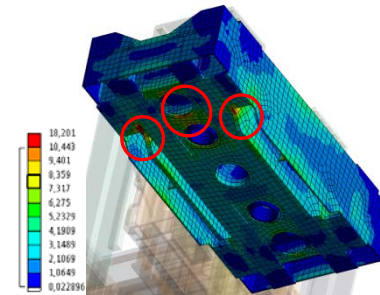
- potential fatigue and/or overload

#### where?

- frame of the press
- steel structure
- selected representative locations

#### which sensor?

- strain gauge
- quarter bridge, rosette



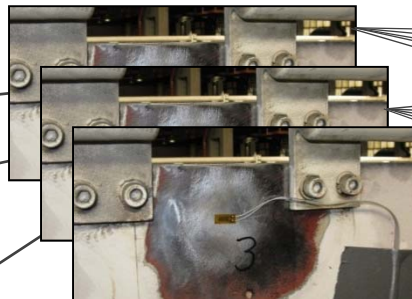
## 4. Solutions

**ECEM – Sub Tasks:** Virtual Sensor Technology for strain (stress) measurement

Forming press

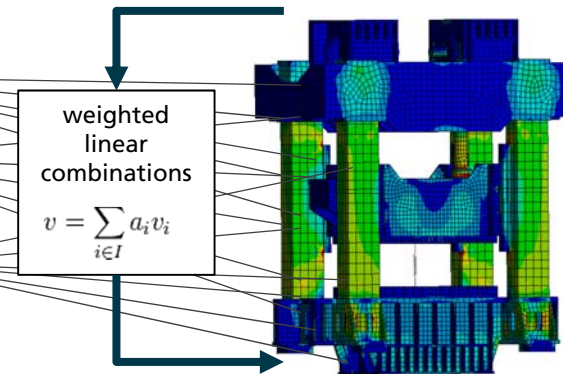


Real sensors



- local selective assessment
- critical zones inaccessible (i.e. indentations)
- **limited information**

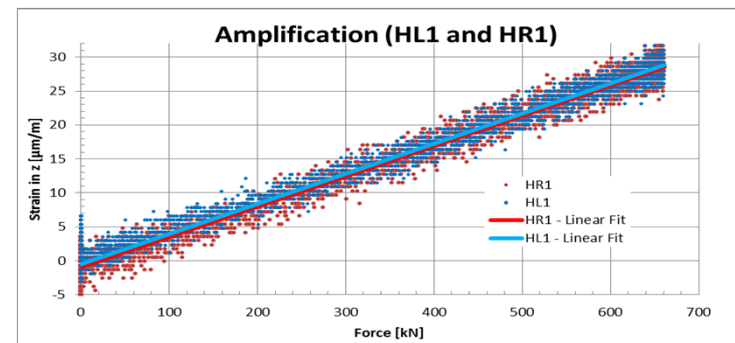
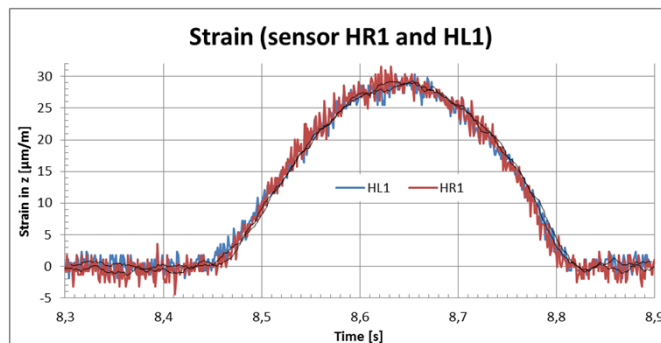
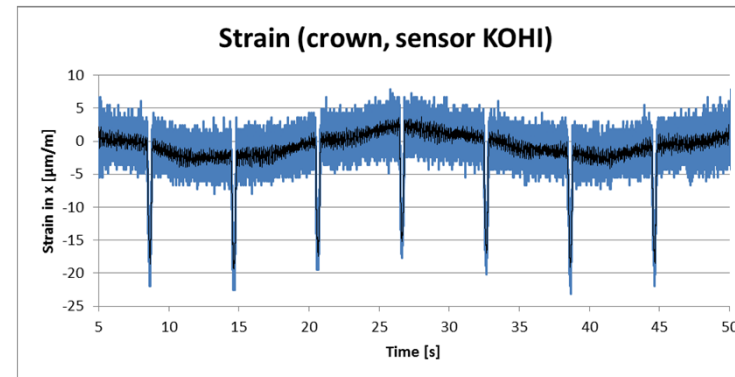
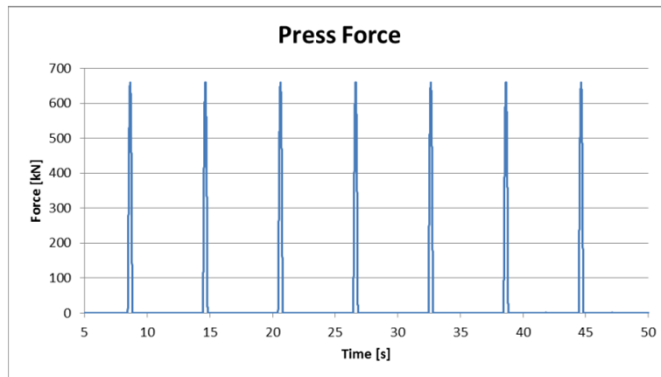
Virtual sensors



- global assessment of complex structures
- cover critical zones
- **"unlimited" information**

## 4. Solutions

### ECEM – Sub Tasks: Model and Virtual Sensor Verification

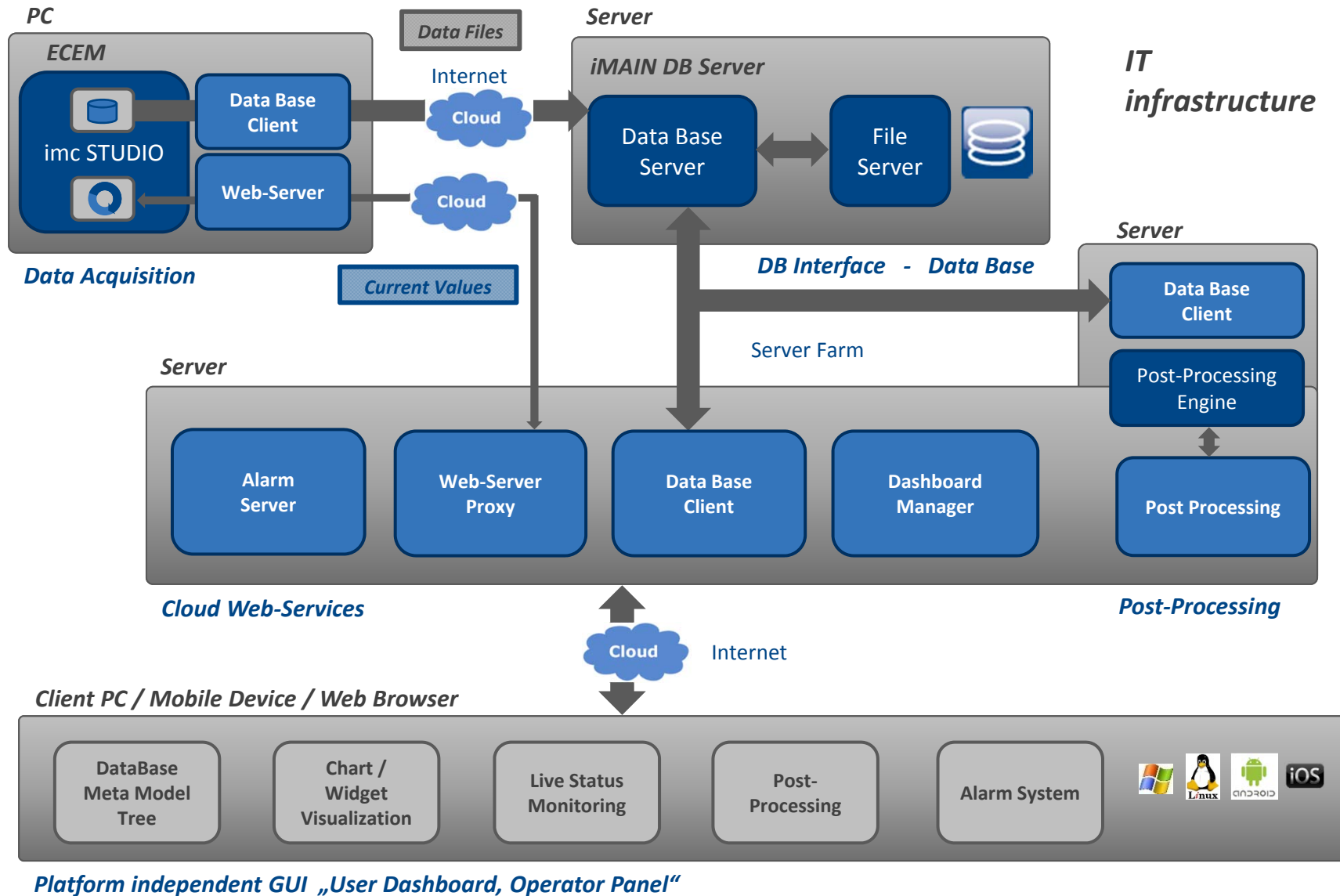


- comparison of measurement and simulation shows a **very good correlation**.
- estimated averaged amplitudes of the strain sensors (20µm/m for the KOH1 in the crown and 29µm/m for HL1/HR1 in the columns) were confirmed exactly
- noise in the unmodified measured signal is about +/- 3 µm/m

## 4. Solutions

### ECEM – Cloud Interfacing

Web Browser Front-End (“User Dashboard”)



# Thank you!



Novel Maintenance Support  
System for Forming Presses

[www.imain-project.eu](http://www.imain-project.eu)

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